group, but in the former case the bright carbon flutings are strongly developed, whilst in the latter they are barely visible. Another characteristic of the later species is the addition of absorption-lines to the narrow bands. The observations of Mr. W. J. Lockyer and myself show that δ Piscium represents a late stage of the group, there being little or no carbon radiation.

(4, 5) Stars of the solar type. The usual differential observations are required.

(6) A star of Group IV. Observations of the relative thicknesses of the hydrogen and additional lines should be made, and the characters and positions of the latter noted. It appears that in some of these stars the added lines are similar to those seen in α Cygni, whilst others are solar.

(7) In this star of Group VI. the blue zone is very pale, the carbon band λ 564 is very wide and dark, and band 4 is suspected (Dunér).

(8) There will be a maximum of this variable on October 31. The period is about 138 days, and the range from 7·5–8·5 to 2·5–13·0. According to Dunér, the spectrum is one of Group I., but excessively weak. More details may possibly be obtained if the spectrum be observed at maximum. A. Fowler.

Spectroscopic Observations (Sawerthal's Comet 1881 I., and β Lyræ).—Dr. Nicolaus von Konkoly, the Director of the Astro-physical Observatory in O'Gyalla (Hungary) has issued the volumes containing his observations made during 1888-89. He notes, with respect to Sawerthal's comet (1881 I.):—

"I have observed the spectrum with a Merz universal spectroscope having one prism in position. This gave a dispersion of 8° (H to D), which was more than sufficient for my purpose. I was obliged to use this instrument, because the deviation it gave suited the focussing arrangement of the Kartaler refractor. The telescope of the spectroscope magnified seven times.

"The continuous spectrum was not very bright, and faded away slowly at each end. I thought that I could distinguish the D line (dark). It was so weak, however, that I could not fix its position with the micrometer. The continuous spectrum extended from 673 μ to 435 μ. Besides this I was able to recognize five hydrocarbon bands which I have located five times. From these measurements I have deduced the following mean values: I. 561·46 μ, II. 546·25 μ, III. 515·88 μ, IV. 513·26 μ, V. 472·56 μ.

"The lines were not sharply defined on either side, and were much widened near the continuous spectrum. The measurements given above are of the middle of the maximum light-intensity of the bands, which could be easily distinguished."

β Lyræ was spectroscopically observed on January 1, 1889, and it is recorded:—"The C line was bright and could be easily seen, and a dark band was visible at a slight distance from it. D_3 was distinguished in a similar manner. Near it, in the green, some fine lines could be perceived. F was suspected, but it was almost invisible."

Dr. Konkoly gives an extended account of his observations of Jupiter from 1885 to 1889, and accompanies it with a series of fourteen drawings of the planet. Several drawings of Sawerthal's comet are also given.

Spectroscopy at Paris Observatory.—M. Deslandres has charge of the spectroscopic section just created at Paris Observatory, and in the current number of *Comptes rendus* (October 20) he gives an account of the instruments to be used with the great equatorial (1·20 metres aperture). Those who have tried to obtain photographs of star spectra by means of a slit spectroscope on a large telescope, know how difficult it is to adjust a star on the slit, and, when there, to keep it in position for a sufficiently long time. To enable this to be done during a long exposure, M. Deslandres has arranged a total reflecting prism near the dark slide, so that the red end of the spectrum may be seen whilst the blue end is being photographed. In this way he has obtained many photographs of stellar spectra in juxtaposition with comparison spectra. To adjust the instrument for observing, the spectrum of a star, a small mirror, having a hole in the centre about the same diameter as the length of the slit, has been fixed in front of the slit at an inclination of 45°. The image of a star is thus reflected to the side of the instrument, and after another reflection reaches a small telescope fixed at the spectroscope. This telescope, therefore, gives the image of a star in the plane of the slit, and constitutes a veritable finder for use with the spectroscope.

ON THE LATER PHYSIOGRAPHICAL GEOLOGY OF THE ROCKY MOUNTAIN REGION IN CANADA, WITH SPECIAL REFERENCE TO CHANGES IN ELEVATION AND TO THE HISTORY OF THE GLACIAL PERIOD.[1]

DR. G. M. DAWSON has been engaged continuously for seventeen years in geological exploration of the Western Territories of Canada, including the country from Lake Superior to the Pacific; and in the paper above named he summarizes the history of the successive deposits and earth-movements which have built up the mountain ranges of the West, and the relations of these to the geology of the great plains to the eastward. He devotes special attention to the Glacial age, and concludes that the drift phenomena of the plains belong to a period of submergence, and that in the extreme period of glaciation there were great glaciers on the Cordillera on the west, and the Laurentian axis on the east, with a vast internal sea between. He is thus entirely opposed, as far as North America is concerned, to the idea of a Polar ice-cap or a great continental glacier flowing down the interior plateau of the continent, and he resolves the phenomena of the ice age into the operation of huge mountain glaciers and floating ice.

The leading points of the memoir may be summarized, with the aid of a few extracts, in such a manner as to convey a general view of the history of the great Cordilleran belt, which stretches along the west coast of America from Behring Straits to Cape Horn, and more especially to indicate that of its more northern portion.

The general structure of the country may be defined as follows:—

"At the present day, the western border region of the continent is formed by a series of more or less nearly parallel mountain-systems, with an average breadth in British Columbia of about 400 miles. The trend of these systems is north-west and south-east, or similar to that of the corresponding portion of the Pacific shore-line, the position of which, in fact, depends upon that of these orographic features. This generally mountainous zone of country is often referred to as the Rocky Mountain region, but is more appropriately named the Cordillera belt, the Rocky Mountains proper constituting only its north-eastern marginal range. In traversing it from east to west, in the southern part of the province of British Columbia, four distinct mountain-systems are crossed: (1) the Rocky Mountains proper, (2) mountains which may be classed together as the Gold Ranges, (3) the Coast Ranges, (4) an irregular mountain-system which in its unsubmerged parts constitutes Vancouver Island and the Queen Charlotte Islands, and which may be designated the Vancouver system. Between the second and third of these mountain-systems is a region without important mountain ranges, which is referred to as the Interior Plateau of British Columbia.

"To simplify our conception of the main features of this part of the Cordillera for our present purpose, we may, however, regard it broadly as being outlined on the north-east and south-west sides by the Rocky Mountains proper and by the Coast Mountains, as dominant ranges. This view is justified by the remarkable constancy of these two ranges and their relative importance. The intervening region may then be described as comprising the Interior Plateau together with the various ranges which have been grouped together under the name of the Gold Ranges, as well as other detached mountains and irregular mountainous tracts."

The geological history of British Columbia begins, like that of many other parts of the world, with that primitive crumpling of the earth's crust which produced the Laurentian gneisses. These exist principally in the Gold Ranges, and are in this region neither greatly extended nor of great elevation. In the Palæozoic age there were sea-bottoms receiving sediment, but apparently little mountain-making.

"Omitting, then, from consideration the imperfectly-known progress of events in the earlier stages of the geological history of the region, we may endeavour to picture to ourselves its condition in the Triassic or first stage in the Mesozoic division of geological time. The central region of the continent was at this time occupied by a very extensive, though shallow, mediterranean sea, which was either entirely cut off from the ocean or had only occasional and brief connection with it, and in which red beds with occasional layers of gypsum and salt were being deposited.[1] Rocks which represent a portion of the bed of this inland sea enter into the composition of the Rocky Mountain Range near the forty-ninth parallel, but are not known to occur to the north of that parallel for a distance of more than thirty or forty miles. To the west, they are not found in the Selkirk or Purcell Mountains. We appear, in fact, to discover in this vicinity the northern end of the inland Triassic sea. To the west of the Gold Ranges (under which term it will be remembered that the Selkirk, Purcell, and other mountains are grouped), deposits, also referable to the Triassic period, and more particularly to its upper part, are again found. These occur both on the mainland of what is now British Columbia and on Vancouver Island and the Queen Charlotte Islands. They contain truly marine fossils, and consist largely of materials of volcanic origin, which give evidence of contemporaneous volcanic activity on a great scale. To the north, in the Peace River country, and to the east of the present position of the Rocky Mountains, rocks holding the same marine forms are found, and they have quite recently again been discovered by Mr. McConnell in a similar position, still further north, on the Liard River.

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[1] By Dr. G. M. Dawson, F.G.S., Assistant Director of the Geological Survey of Canada. Transactions of the Royal Society of Canada, 1890. 73 pages quarto, with 4 maps.

"It would thus appear that in Triassic times the eastern border of the Pacific washed the western slopes of the Gold Ranges, and that where this mountain-system became interrupted, in its northern part, the sea was continued across its line, and covered a large tract of country to the east of the present position of the Cordillera belt.

"Precisely how far to the east the shore of this northern expansion of the Pacific was situated has not yet been determined. The region between it and the northern end of the inland sea previously referred to must have been a land area, which separated the open ocean of the north from the Mediterranean on the south. The Rocky Mountains proper had not yet been formed, nor is there any evidence of mountain ranges in the region of the Coast and Vancouver systems of to-day, though the volcanic action there in progress may have produced insular volcanic peaks. The deposits of the inland Triassic sea, including as they do beds of salt and gypsum, appear to prove the existence of a very dry climate in the area occupied by it; and as the land barrier separating it from the moisture-bearing westerly winds of the Pacific cannot have been wide, it must have been high. It is thus probable that the mountains of the Gold system formed at this time a lofty sierra, which was continued to the south of the forty-ninth parallel by the Cabinet, Cour D'Alaine, Bitter Root, and other mountains at least as far as the Wahsatch Range in Utah.

"The Triassic period was closed by one of those epochs of folding and dislocation of strata which are found to be recurrent in geological time, and which are generally attributed to the secular contraction of the earth's crust. The evidence of this time of change has been examined in greatest detail in the vicinity of the present coast-line, where it resulted apparently in outlining the Vancouver and Coast Ranges, and was accompanied by the production or extravasation of great masses of granitic rocks.[2] It is highly probable that some corrugation along the line of the Rocky Mountains occurred at the same period, as, in the next succeeding Earlier Cretaceous strata, without further evidence of disturbance, conglomerates are found to be composed of fragments of many varieties of the older rocks, which could scarcely otherwise have been rendered subject to denudation. Though much remains to be discovered respecting this post-Triassic epoch of disturbance, it was evidently an important one, and its results were wide-spread in the Cordillera region. It is quite possible that it was accompanied by, or resulted in producing, a general elevation of this entire region above the sea-level, as no rocks distinctly referable to the Jurassic or next succeeding period have yet been distinctly recognized either in British Columbia or in its bordering regions.[3] It must be borne in mind, however, that a portion of the red beds of the inland sea, described as Triassic, may extend upward into the Jurassic period, and that the marine Triassic fossils of the western and northern sea are referable to the later stages of the Triassic, or 'Alpine Trios' of the Cordillera region, comparable with the St. Cassian and Hallstadt beds of the Alps in Europe; while the beds of the Cretaceous next found are, according to European analogies, near the base of that formation."

"The next distinct record of the physical conditions of the region under discussion is afforded by the Earlier Cretaceous rocks. These, on the evidence of contained molluscan fossils, are regarded as about equivalent to the Gault of England, though the associated remains of plants are such as to admit their assignment to a somewhat older date. At this time, the immediately post-Triassic elevation had been followed by a subsidence of the land, resulting in the re-occupation by the open sea of the great area which had been similarly characterized in the Triassic. As in Triassic times, we find that this Earlier Cretaceous extension of the Pacific, to the north of the fifty-fourth parallel, spread eastward in a more or less connected manner completely across the present position of the Cordillera belt, while the Gold Ranges, and probably also other insular areas, continued to exist as dry land. In this case, as in that of the Triassic, it has not yet been found possible to outline exactly the eastern limit of the sea, in consequence of the want of sections cutting down to the base of the Cretaceous in the area of the Great Plains. There are, however, reasons for believing that it did not extend far beyond the line of the present foot-hills of the Rocky Mountains.

"In one important particular, the conditions in this Earlier Cretaceous period differed from those of the Triassic. There was at this time no isolated inland sea, and waters in connection with the main ocean stretched southward to the east of the Gold Ranges as far as the forty-ninth parallel and beyond it to a further distance which is as yet undetermined. This extension of the open sea thus actually overlapped, to a considerable extent, the area formerly occupied by the Triassic mediterranean."

This was followed, however, in Middle and Later Cretaceous times, by a great depression in which the marine beds of the Neobrava and Pierre Groups were deposited. This submergence was succeeded by some measure of elevation or folding, leading to the existence of vast swampy and lacustrine flats, in which the lacustrine and peat deposits of the Laramie formation of the great plains were formed. These deposits may be regarded as closing the Cretaceous era, or as transitional between it and the Eocene.

"This state of affairs was brought to a close by another of the recurrent epochs of folding and dislocation of the earth's crust, which was one of the greatest of those of which we find the results in the region under discussion, as well as the last of an important character to which this region was subjected. Under the influence of enormous pressure acting from the Pacific side, the nearly horizontal strata, which bordered the Gold Ranges on the north-east, were folded together and thrown up into a dominant ridge of Alps, which finally outlined the Cordilleran belt on this side. A similar folding and upthrust affected also the western marginal mountains which have been referred to as the Vancouver Range, but the action was there probably less violent and certainly affected a narrower zone. A portion of the crumpling to which the rocks of the Coast Ranges have been subjected was doubtless also produced at or about the same time, and certain granitic extrusions which cut the earlier Cretaceous rocks on its eastern flanks, as well as much of the flexure of these Cretaceous rocks, are also attributed to this period of disturbance.

"There is really no means of ascertaining what effect this disturbance produced in the region of the Gold Ranges, but it is more than probable that the whole width of the Cordillera then suffered changes and deformation of such a character that little if any trace of its surface contour of an older date can be found to-day.[1] It does not, however, necessarily follow that the general altitude of the Cordillera belt was at this time materially changed. The greater part of the accumulated pressure appears to have been relieved by folding along the lines of its two bordering ranges, and it seems to be not improbable, as a general proposition, that changes in elevation affecting wide areas are due to other causes than those producing mountain ranges.[1] We are warranted in assuming, however, that a certain movement in elevation was coincident, or nearly so, with that of the great disturbances above outlined, as no strata representative of the Eocene period proper have yet been found anywhere in the western part of Canada. The entire area of the Great Plains was thus sufficiently elevated to become dry land, as occurred at the same time in the Western States to the south of the international boundary."

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[1] Cf. "Note on the Triassic of the Rocky Mountains and British Columbia," Transactions of the Royal Society of Canada, vol. i., Section iv., p. 143.

[2] Cf. "Report of Progress, Geological Survey of Canada," 1878–79, pp. 46 B, 48 B; "Report of Progress, Geological Survey of Canada," 1886, p. 15 B.

[3] Certain rocks, from which fossils supposed at the time to be Jurassic were described, have since been found to belong to the Earlier Cretaceous. Cf. "Report of Progress, Geological Survey of Canada," 1876–77, p. 150; "Mesozoic Fossils," vol. i. p. 258.

[1] In respect to this great epoch of orographic movement, as evidenced particularly in the more southern part of the Cordillera, which has now been somewhat closely studied, Mr. S. F. Emmons may be quoted as follows:—"It is unquestionably one of the most important events in the orographic history of the entire Cordilleran system. With the exception of the great unconformity between the Archæan and all overlying sediments, which is a phenomenon *sui generis* and altogether exceptional, no movement has left such definite evidence as that which follows the deposition of the coal-bearing rocks to which the name Laramie has by universal consent been applied."—*Bulletin Geol. Soc. Amer.*, vol. i. p. 285.

The Eocene period thus witnessed the formation of the great interior table-land, which accordingly has present no aqueous formations of this age. In Miocene times, however, there were large interior lakes, with deposits rich in remains of plants and insects, and on the plains fluviatile gravels with mammalian bones.

The Pliocene period inaugurated another great continental elevation, which continued for a long period, and in which the fiords and cañons of the Cordillera were cut down by fluviatile action to the sea-level of the period. Many local illustrations are given in this memoir of the curious results in regard to denudation which this period of rest and elevation produced.

This leads to the glacial history of the region, the key to which is believed to be found in the unequal elevation whereby, while the great plains to the east remained under water, the Cordilleran Ranges became covered with a great glacier discharging north toward the Yukon Valley and the Arctic Sea, and south to Puget Sound, while glacial streams ran westward to the Pacific. At this time the Rocky Mountains produced but few and small glaciers on their eastern sides; but across the wide sea which covered the plains the Laurentian Mountains supported another *névé* discharging ice in all directions.

This was followed by what is usually called the inter-glacial period, when, as is believed, the plains were slightly elevated and the mountains depressed; and this was succeeded by the second glacial period, in which the mountain glaciers were comparatively small, and the depression of the plains was so great that water-borne boulders were deposited at elevations of 5000 feet or more on the foot-hills of the Rocky Mountains. It is to be noted here that the present eastward slope of the western plains had not yet been impressed on them. The series of events thus indicated is illustrated by the following table, which, however, the author regards as somewhat provisional:—

SCHEME OF CORRELATION OF THE PHENOMENA OF THE GLACIAL PERIOD IN THE CORDILLERAN REGION AND THE REGION OF THE GREAT PLAINS.

Cordilleran Region.	*Region of the Great Plains.*
Cordilleran zone at a high elevation. Period of most severe glaciation and maximum development of the great Cordilleran glacier.	Correlative subsidence and submergence of the Great Plains, with possible contemporaneous increased elevation of the Laurentian axis and maximum development of ice upon it. Deposition of the lower boulder-clay of the plains.
Gradual subsidence of the Cordilleran region and decay of the great glacier, with deposition of the boulder-clay of the Interior Plateau and the Yukon Basin, of the Lower boulder-clay of the littoral, and also at a later stage (and with greater submergence) of the inter-glacial silts of the same region.	Correlative elevation of the western part of the Great Plains, which was probably more or less irregular, and led to the production of extensive lakes in which inter-glacial deposits, including peat, were formed.
Re-elevation of the Cordilleran region to a level probably as high as or somewhat higher than the present. Maximum of second period of glaciation.	Correlative subsidence of the plains, which (at least in the western part of the region) exceeded the first subsidence, and extended submergence to the base of the Rocky Mountains near the forty-ninth parallel. Formation of second boulder-clay, and (at a later stage) dispersion of large erratics.
Partial subsidence of the Cordillera region to a level about 2500 feet lower than the present. Long stage of stability. Glaciers of the second period considerably reduced. Upper boulder-clay of the coast probably formed at this time, though perhaps in part during the last.	Correlative elevation of the plains, or at least of their western portion, resulting in a condition of equilibrium as between the plains and the Cordillera, their *relative* levels becoming nearly as at present. Probable formation of the Missouri Côteau along a shore-line during this period of rest.
Renewed elevation of the Cordillera region with one well-marked pause, during which the littoral stood about 200 feet lower than at present. Glaciers much reduced and diminishing, in consequence of general amelioration of climate toward the close of the Glacial period.	Simultaneous elevation of the Great Plains to about their present level, with final exclusion of waters in connection with the sea. Lake Agassiz formed and eventually drained toward the close of this period. This simultaneous movement in elevation of both great areas may probably be connected with the more general northern elevation of land at the close of the Glacial period.

Among the evidences given of the partial submergences and differential elevations stated in this table, reference is made to the "White Silt formation" so extensively distributed in many parts of British Columbia, and indicating water action up to levels of about 2700 feet, to the high-level terraces; the peculiar distribution of boulders from the Laurentian highlands on the eastern slopes of the Rocky Mountains; the absence of glacial abrasion on the plains; the chemical character of the boulder-clay, leading to the inference that it was formed under water; the wide distribution and characters of the inter-glacial beds, the character and position of the Missouri Côteau, and a variety of other local facts. The objection that marine shells are not found in the Pleistocene strata is treated thus:—

"From what has already been said with respect to the Cordillera region, and more particularly in connection with the meaning which the White Silt formation appears to have in that region, it seems probable that the water by which the northern part of the Great Plains is supposed to have been flooded was in connection with that of the sea.[1] In discussing the results of my earlier investigations of the superficial deposits of this part of the plains, in reference to a theory of their submergence, I have stated that after a certain stage the waters entering from the north and south must have formed an open strait between the Arctic Ocean and the ocean to the south.[2] This was written, however, under an assumed limitation implying an equal subsidence of the continent; and at the time no satisfactory information was available respecting the position of the margin of the glacial deposits in the corresponding western part of the United States, such as has since been supplied by the work of Chamberlin, Salisbury, Todd, Wright, McGee, Upham, and others. The result of these new facts appears to show that, instead of opening broadly southward as well as to the north, any body of water covering the northern part of the Great Plains could have had only a tortuous and comparatively narrow communication with the sea to the eastward, round the front of the great confluent Laurentide glacier, and that even this communication was probably formed only at the time during which the plains stood at the lowest level indicated by the spread of the drift deposits. If such conditions may be assumed as probably representing the facts at the time, they go far toward explaining one of the greatest difficulties against the acceptance of the hypothesis that the waters by which the plains were flooded were in communication with those of the sea. The difficulty alluded to is the complete absence, so far as yet ascertained, of the remains of marine organisms from the glacial deposits. While prolonged weathering and the action of sub-aërial waters might result in the removal of calcareous organic remains from certain parts of these deposits, the condition of much of the boulder-clay, together with the occasional actual occurrences in it of fragments of Cretaceous or Laramie shells, is such as to show that any contemporaneous mollusks might have been preserved. If, however, the body of water in question, though communicating with the sea to the northward, was almost throughout closed to the south and in receipt of large quantities of fluvial water, it may well have been in great part brackish, if not almost entirely fresh. Adding to this the conception of its frigid temperature due to the great abundance of ice with which it must have been laden, and the vast amount of fine sediment which must have been carried into it by sub-glacier streams, it will be apparent that the conditions were singularly inimical to the existence of life of any kind, whether that characteristic of salt or fresh water. Somewhat similar conditions, though on a much smaller scale and without the adjunct of glacial waters or glaciers, occur in the southern extremity of Hudson Bay, where, as Mr. A. P. Low informs me, marine life is almost entirely absent, the water being nearly fresh and clouded with mud derived from the large entering rivers and from the action of the waves upon the shallow earthy shores."

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[1] Cf. Le Conte, *American Journal of Science*, III. vol. xxxii. p. 178.

[1] It must still, however, be admitted as possible, that a great lake was in some manner produced, in the region of the plains, with a height somewhat exceeding that of the sea.

[2] "Geology and Resources of the Forty-ninth Parallel," p. 255.

Finally the climatal conditions deducible from the geological facts coincide with these facts in enforcing the probability that the great ice age of North America depended mainly on the existence of high mountains, surrounded by submerged areas, traversed by ice-laden currents, and that we are to imagine, not a continent covered with ice, but a submerged continent, with snow-clad mountains rising at its margins, and forming the gathering grounds of great local glaciers—the *Cordilleran*, the *Laurentide*, and probably the *Appalachian* glaciers. These were the favouring conditions, but the author does not venture to deny the co-operation of other and cosmical causes. He concludes as follows:—

"When the study of the superficial deposits of different parts of Europe and America was for the first time seriously begun, it was endeavoured to explain the phenomena entirely by diluvial action, and when the evidence of ice-action became insuperable, icebergs and floating ice only were at first admitted as factors. Since that time the pendulum of opinion appears to have swung to the opposite extreme, and the energies of the majority of investigators have been extended in endeavouring to account for the varied facts of what has become definitely known as the Glacial period, almost exclusively by the action of great confluent glaciers. From this extreme point, the pendulum may now be supposed to have returned so far, as to leave the hypothetical North Polar ice-cap almost without an advocate, but at what position it may eventually come to rest time alone can decide. I am aware that some of those who have accepted what I may perhaps be pardoned for characterizing as extreme views as to glacier action, have more or less completely, and to their own satisfaction at least, solved all difficulties opposed to the action of land ice, such as those presented by the facts met with over the Great Plains, by the application to these of their single universal menstruum. For myself I need only say that I have endeavoured to approach the subject of the glaciation of the north-western part of the continent, here reviewed, untrammelled by *a priori* theories, and with some personal familiarity in the field with nearly all parts of the region dealt with."

The above is only a hurried and imperfect summary. The paper itself, as containing the matured conclusions of long and thorough investigation by an able and earnest explorer, should be carefully read by all interested in the structure of the Great Cordilleran backbone of the American continent.

THE SCIENTIFIC INVESTIGATIONS OF THE FISHERY BOARD FOR SCOTLAND.[1]

THE results of the scientific investigations for 1889 are given in full detail with numerous tables and two charts. It was found that, during the year, no increase but rather a decrease, mainly in the migratory round fishes, occurred in the closed waters, and likewise in the open waters adjacent, the results of 1887 having been proved exceptional. The results of concurrent investigations carried on on board the *Garland* into the food of fishes, their spawning, and the distribution of the young, show that great and important differences—which must be taken into consideration both from a scientific and legislative point of view—prevail among the various food-fishes (Section A).

Dr. Wemyss Fulton, in his paper on the distribution of immature sea-fish and their capture by various modes of fishing, gives the results of the investigations into this important subject. The fundamental question as to what an immature fish is, has been determined for the first time by the examination and measurement of 13,000 fishes. The maximum size (as given in detailed tables) varies very much according to the species; any law regulating the legal sale of fish on the principle of size is therefore not based on scientific data. The distribution differs in the same way, but territorial waters serve as nurseries for the young fish. Tables given show the distribution of immature fishes at distances from the shore up to 22 miles and in various depths of water. Details are also given as to the proportion of immature food-fishes captured by the various modes of fishing. Dealing practically with the wasteful destruction of immature food-fishes, Dr. Fulton points out the difficulty of deciding among the different species, and shows how difficult it will be to save immature fish from capture and destruction by the beam-trawl, as that engine is now employed. The recommendations briefly are: that an inquiry should be made as to the retention of vitality by the various kinds of immature fish brought up in the trawl in order to ascertain the chances of survival if replaced in the sea; the protection of nurseries whose areas are capable of definition; the preservation of flat-fish under a certain size; and the establishment of hatcheries for sea-fish. A simple method is explained by which fishermen and trawlers might add to the fish-supply by fertilizing the ova of ripe fish when captured.

Regarding this Report, it should be noted that the importance of this question is not a thing which has dawned upon the Scottish Fishery Board since the conduct of scientific investigations was placed under new management (that of Dr. Fulton). In this paper, as in many others—indeed, everywhere in this year's Report—the willingness to ignore all that was done during the years that Prof. Ewart was convener of the Scientific Committee is very evident. In the Report of 1887 it is stated that "We have organized a series of extensive and systematic inquiries into the conditions of the reproductive organs of various kinds of fishes throughout the entire year, with particulars as to their size, &c., *which will help to clear up the hitherto obscure problems as to the minimum size of sexually mature individuals, &c.*" We have certain information that the original discoveries which led to this Report on immature fish were made by one who has done more than his share to redeem the work of the Fishery Board. And it is only fair that the credit which is Mr. T. Scott's due, and which is denied him there should be acknowledged here.

Dr. Fullarton furnishes a Report, with chart, on the cockle-beds of Barra (in the Hebrides), which furnishes the chief cockle-fishing in Scotland. It is desirable—and the wish of the fishermen themselves—that means should be taken to prevent the taking of undersized cockles, and to insure the working of the beds in rotation.

Dr. Fullarton also gives a paper on oyster-culture fauna in France and Holland. It is most desirable that scientific and practical measures should be taken to revive the Scotch oyster-fishing, which has gradually declined, and these should be planned on known and tried lines. The same must be said of the cultivation of mussels, and this should be urged even more strongly, as their scarcity or abundance are of the utmost importance to the line-fishermen. Lobsters also call for practical legislation and artificial cultivation. The Fishery Board are constructing a lobster inclosure at Brodwick, Arran, and hope that means will be provided for their carrying on operations at the recently established hatchery at Dunbar.

Section B contains the biological investigations. The food of fishes was dealt with in an elaborate Report by Mr. Ramsay Smith, based upon the examination of many thousand food-fishes which prove to live chiefly upon Crustacea, Annelids, Echinoderms, Mollusks, and upon one another. There are great differences, however, as to the proportion of the organisms selected as food by different fishes, and the proportions of the

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[1] "Eighth Annual Report of the Fishery Board for Scotland." Part III. Scientific Investigations.